D0 Note 4430: Overview of Run IIb L1 CAL Installation & Infrastructure

- Introduction
- Constraints
- Transition System
- Cabling
- Run IIb Racks
- Schedule Overview
- Installation
- Summary

Patch Panels on Sidewalk Test Stand

All photos and schematics shown in this talk and supporting documentation can be found at or linked from the following URL:

www-clued0.fnal.gov/~alstone/D0Work/L1Cal/l1cal.html

Introduction: L1 CAL Trigger Signal

- The trigger pickoff of the Calorimeter signals takes place on the Baseline Subtractor (BLS) cards on the detector platform.
  - Calorimeter + ICD has 55296 total electronics channels but 7932 channels are invalid:
    - 7880 by design (Detector vs. Preamp vs. BLS mapping).
    - 46 because of broken cables between Preamp and BLS.
    - 6 non-connected ICD channels due to the helium lines for the Solenoid.
  - 1152 BLS cards each with 4 CAL Precision Towers: 2 η x 2 φ x 12 depth (EM & HAD layers).
- The signals from the physics channels for all EM and Hadronic layers are added with the appropriate weights to form the analog trigger sums and then passed through trigger summer drivers.
  - There are 2560 such drivers – one for each of the 1280 Trigger Tower (TT) EM & HAD components.
  - Note: For $|\eta|>3.6$, each BLS sends 2 TTs sums: 1152+(2)(2)(32)=1280.
- These analog sums are transported differentially to the L1 Calorimeter Trigger electronics on the first floor of the Moveable Counting House (MCH1). [See Slide 3]
  - Each TT (EM+,EM-,HD+,HD-) signal is carried along four consecutive coaxial cables to MCH1 and distributed among ten racks (M103-M112).
- The trigger eta & phi has a factor of two larger granulation than the precision readout (physics) eta & phi.
  - Note: Precision and Trigger have the same Tower eta resolution for $|\eta|>3.6$.
- Each L1 CAL trigger rack receives as inputs TT cables from all phi (1:32) for a consecutive group of eta (+1:+4, -1:4, +5:+8 … +17:+20, -17:-20).

Run IIa L1 CAL Trig Electronics

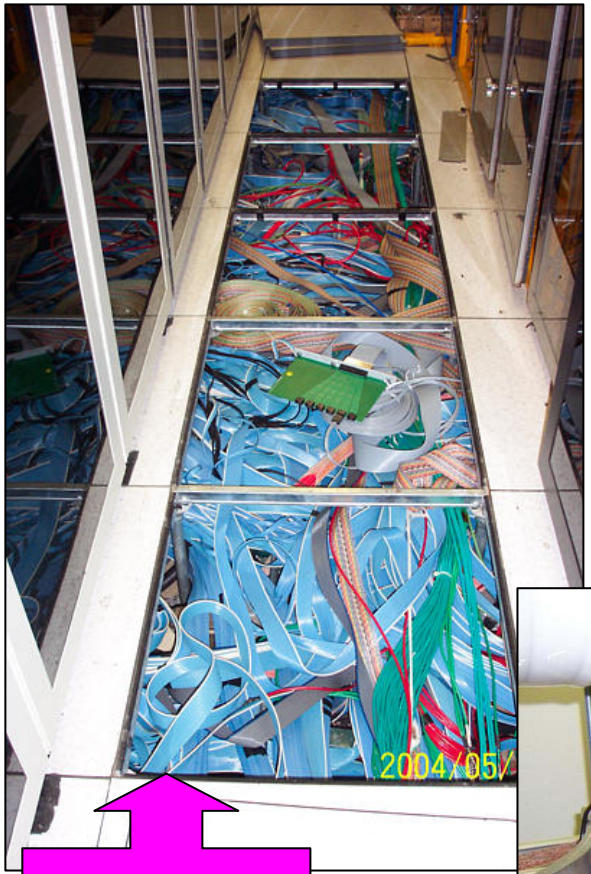
Ten racks of trigger electronics. 128 BLS trigger cables are routed to each rack.

Constraints

- TDR - Reuse Run I BLS trigger cables.
- 78 & 80 Ohm impedance, 130-180 ft in length.
  - Installed circa 1990.
  - Cannot access to cables at the CAL BLS detector platform end.
  - 10-20 ft of slack at MCH1.
- Congested space beneath floor boards.
  - No place to store cables between decommissioning of Run IIa & installation of Run IIb.
  - Exceptional difficulty in locating spares.
  - See photos on Slide 5

- New electronics are more compact.
  - 4 crates (new) vs 20 crates (old).
  - Cable congestion at ADF and TAB backplanes.
    - 1280 BLS, 240 LVDS cables.
  - Channel mapping, strain relief.
- ADF backplane connector mismatch.
  - Cannot plug 8-pin BLS trigger cable connectors directly into 20-pin ADF backplane connectors.
  - Cannot plug LVDS cable into ADF backplane without removing key.
- ADF-to-TAB signal flipping.
  - TAB backplane connectors assume a different orientation of signals from ADF backplane output.
- Cable access & channel debugging.
  - Use scope during physics data taking without disconnecting signal cables.

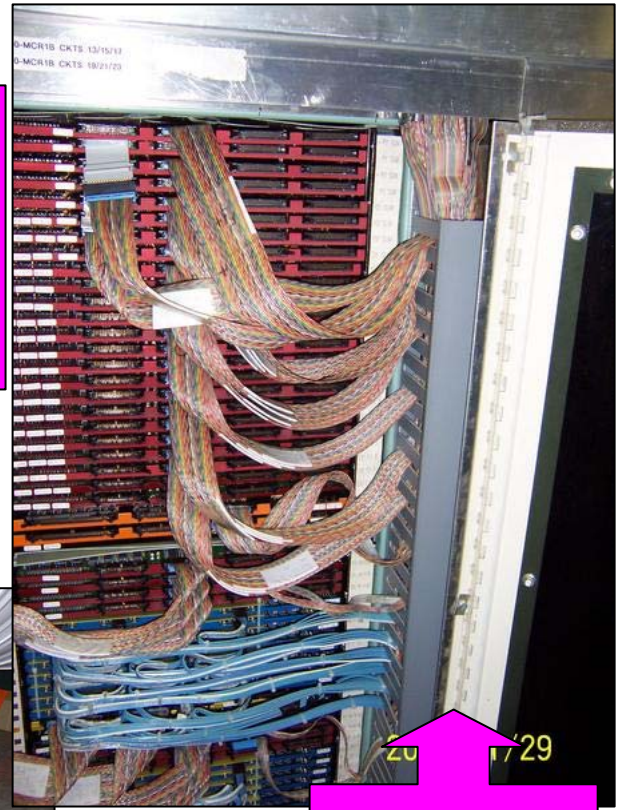
Current MCH1 L1Cal Cabling



Center Aisle

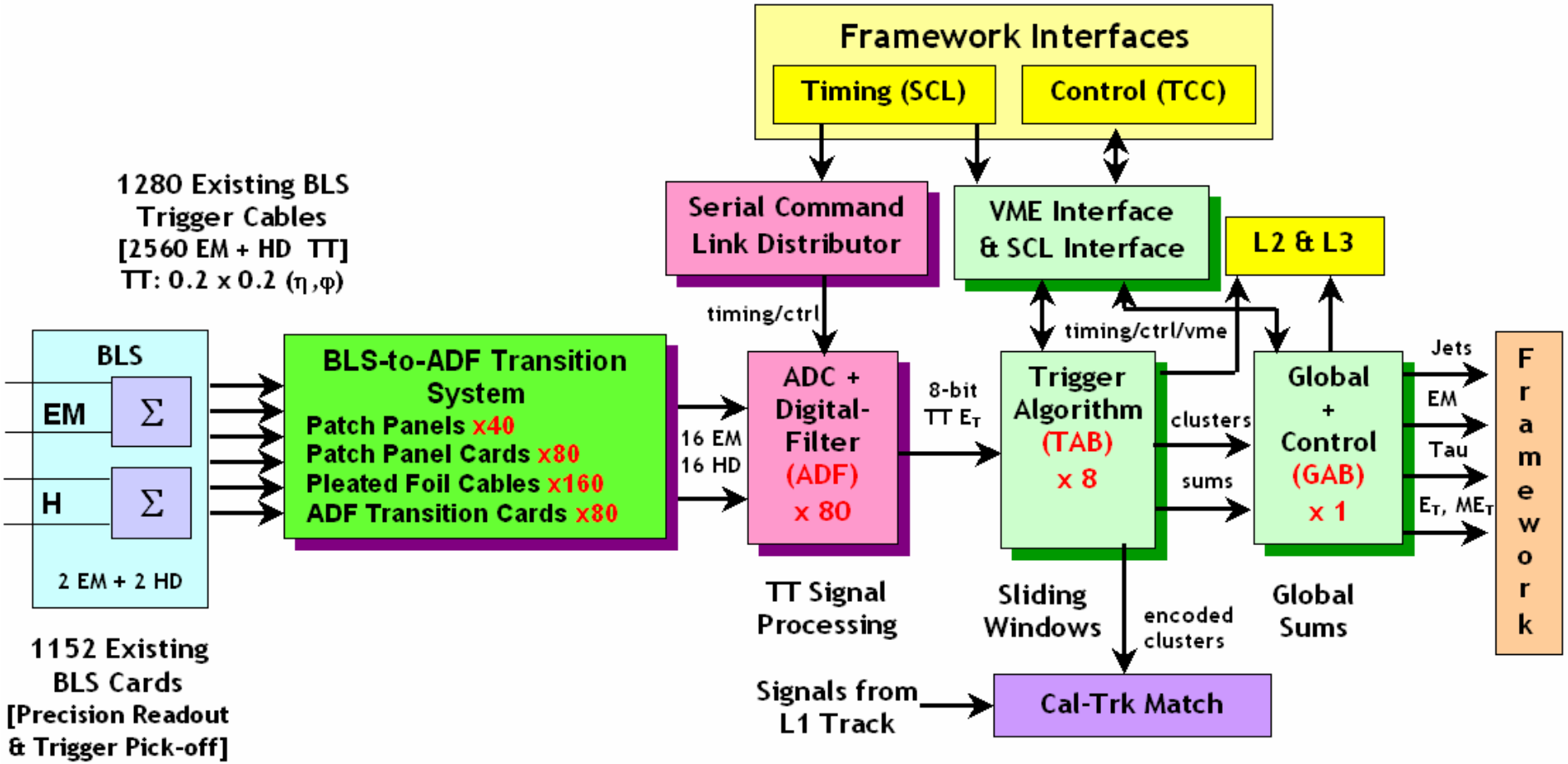
M103, Rear

Cable Tray Above Racks

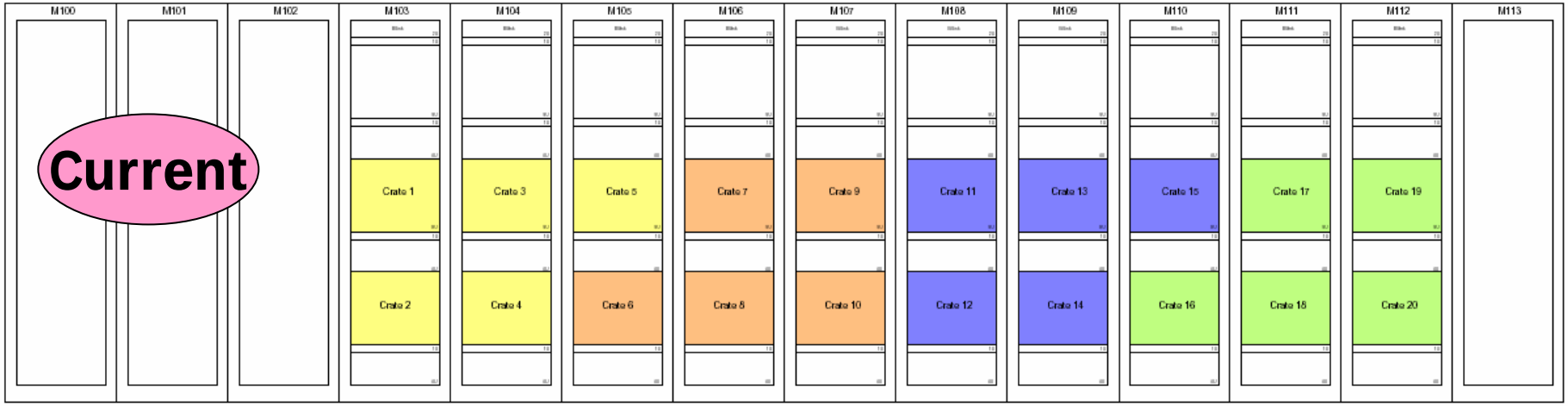


M107, Front

Run IIb L1 CAL Signal Overview

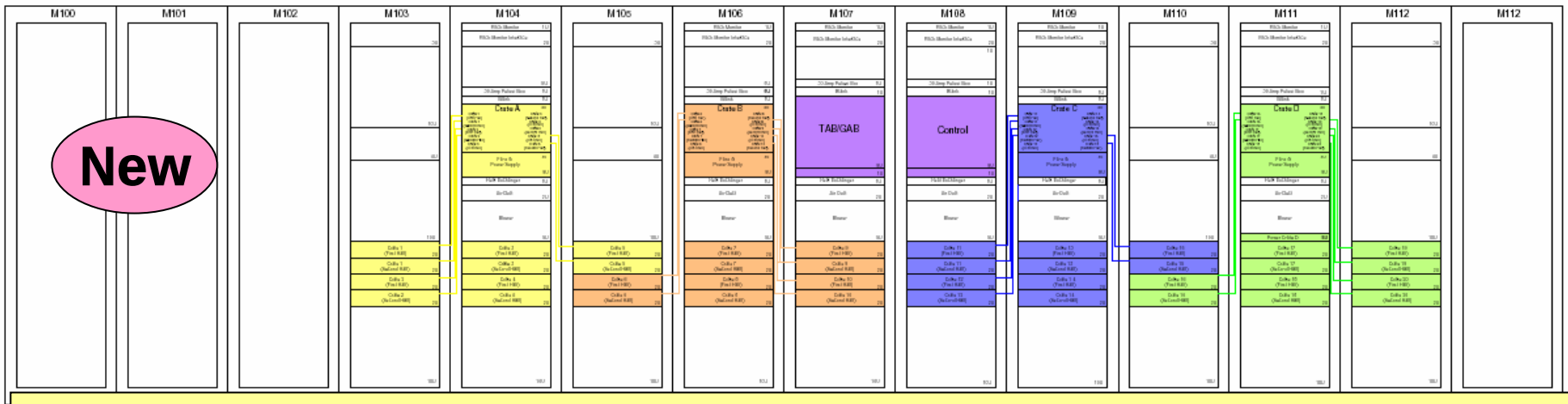


MCH1 Configuration



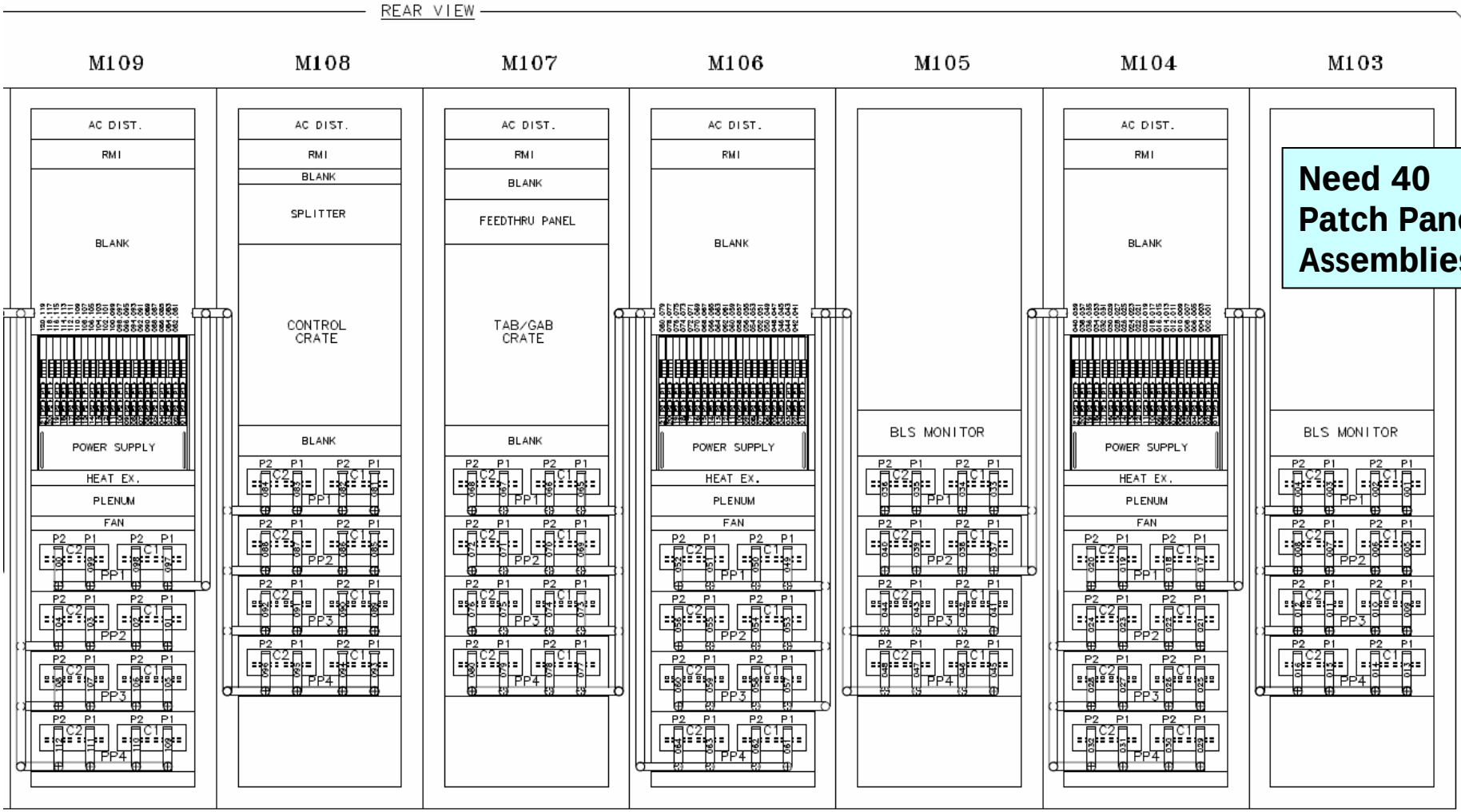
- Color coding illustrates the current & new BLS trigger inputs.
- Ten racks of Run I trigger electronics. 128 BLS trigger cables are routed to each rack.

L1 Cal Tracking MCH1 Rack Assignments
(New Configuration)



- Four patch panels in the bottom half of each crate provide the mechanical means to route and support the BLS trigger cables.

Patch Panel Assemblies

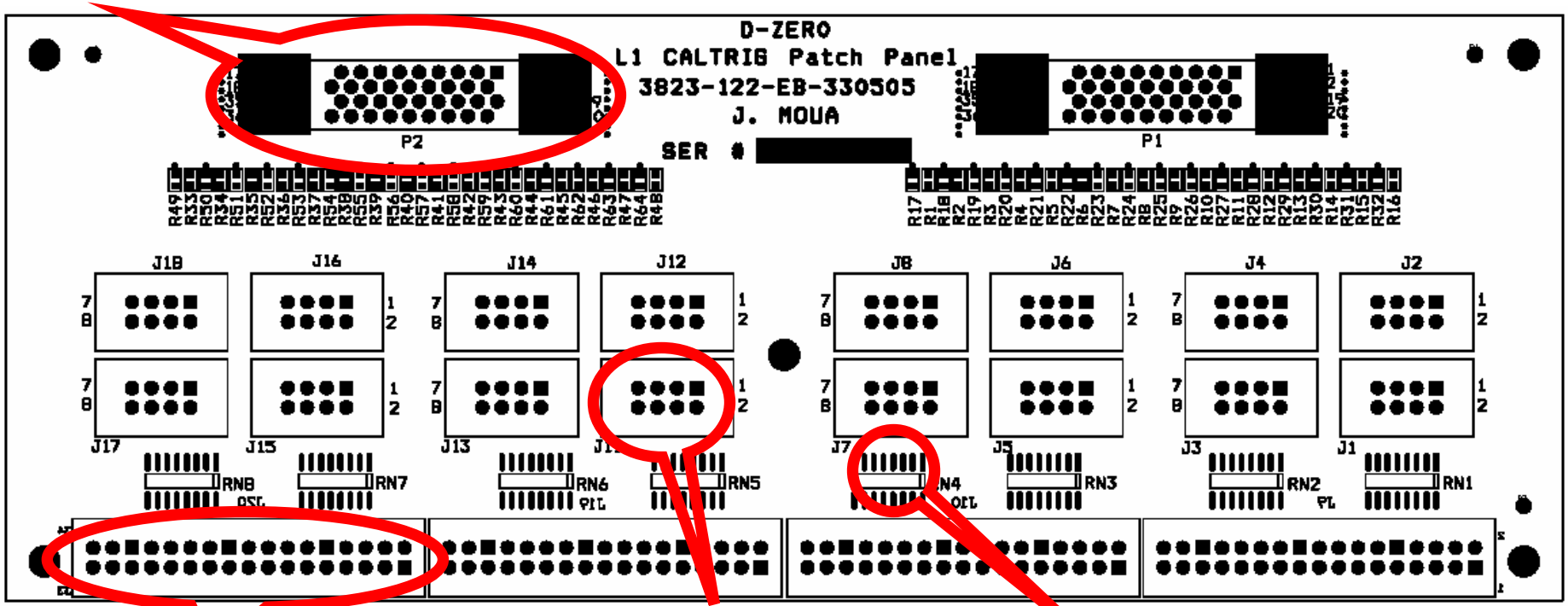


Need 40 Patch Panel Assemblies.

Four patch panels in the bottom half of each crate provide the mechanical means to route and support the BLS trigger cables and transition system. [See photo on first slide]

Patch Panel Card

Output to ADF (Pleated Foil Cables)



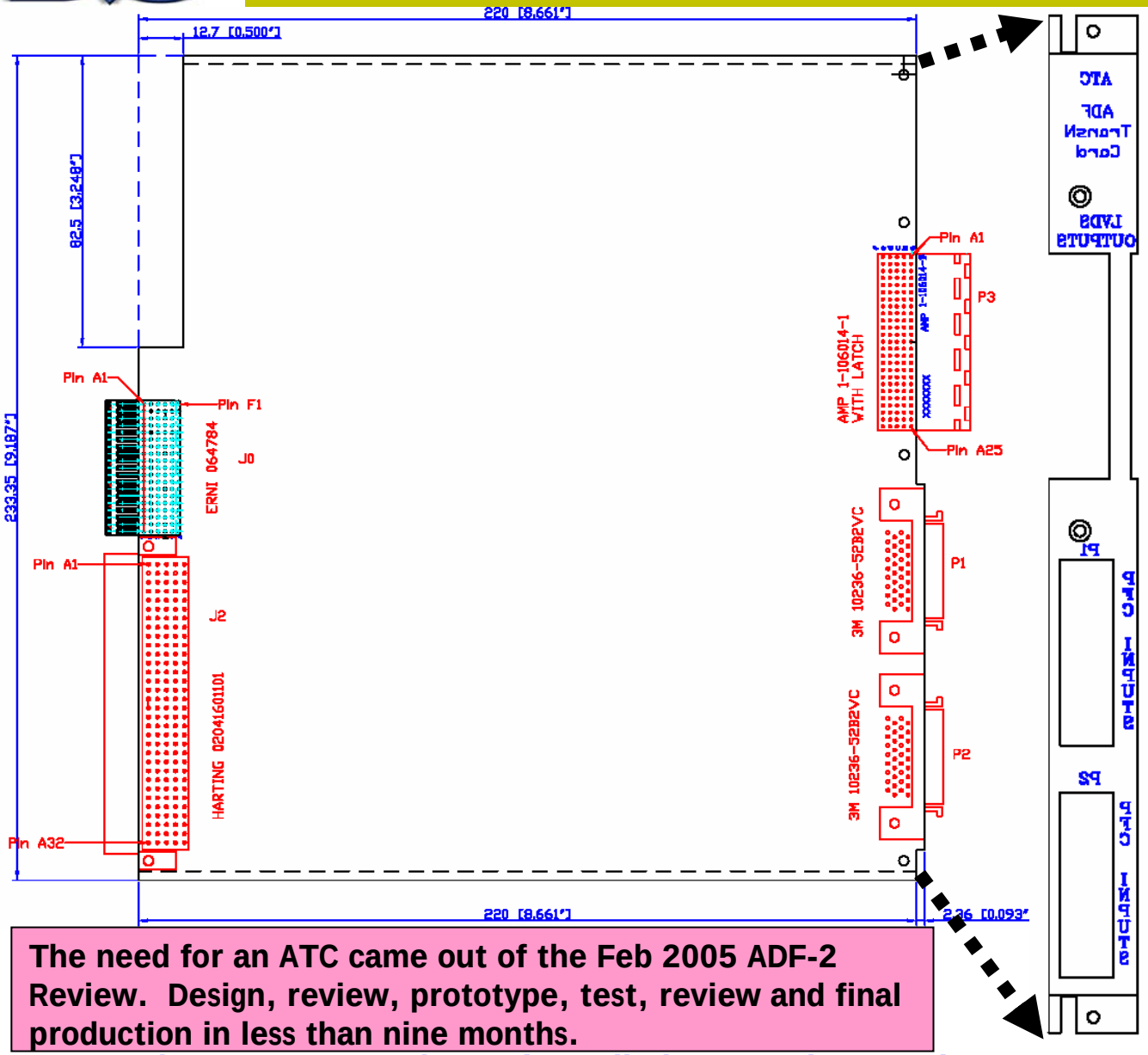
Monitor connectors

Input from BLS

In line resistors

Two passive patch panel cards – stuffed printed circuit boards – mounted to each patch panel. Only the monitor connectors are visible from the front of the patch panel. Cables are connected from the back. Need 80.

ADF Transition Card & Faceplate



Two pleated foil cables carry analog TT signals from each patch panel card to the ADF Cards via the ADF backplane.

Three LVDS cables carry the the same digital ouput of the ADF Cards to three different TABs via the TAB backplane.

Need 80 of each.

The need for an ATC came out of the Feb 2005 ADF-2 Review. Design, review, prototype, test, review and final production in less than nine months.

Big kudos to Johnny Green, John Fogelsong, John Anderson, Dan Edmunds and Linda Bagby.

Cabling

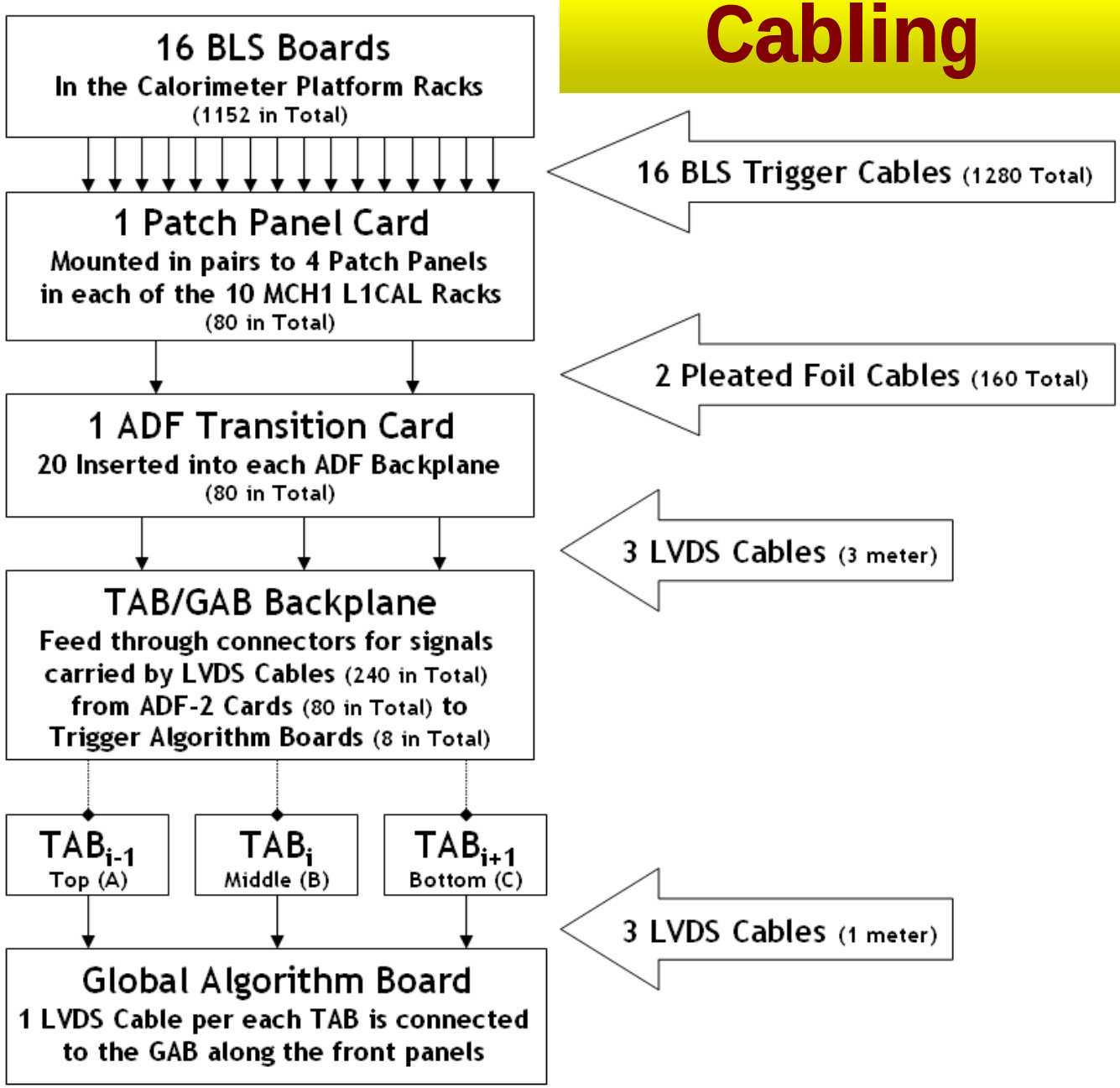
Each label has a unique, clear, concise and unambigious NAME, ORIGIN and DESTINATION.

BLS trigger cables will be labeled as they are disconnected from the old electronics.

Pleated Foil and LVDS cables will be labeled after they have been tested in conjunction with the transition system components.

The interrack wiring and strain relief systems have been exercised with mechanical mock-ups, and then procedures documented.

Documented in D0 Note 4768



Cabling: BLS Trigger Cables

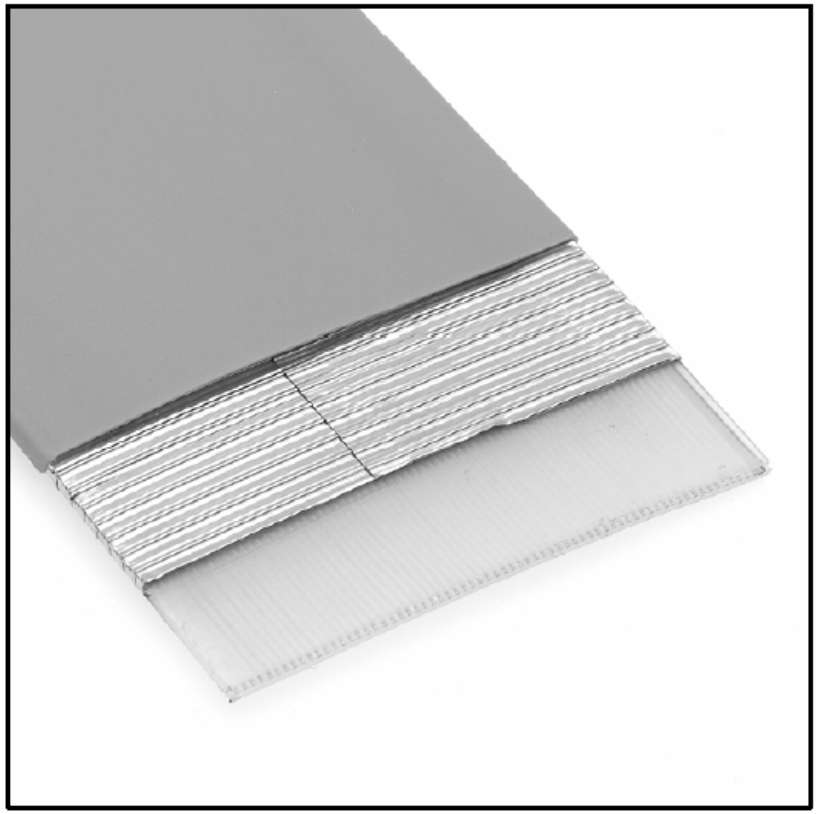
- **Before Run I disassembly**
  - Prepare map of dead and noisy BLS lines
  - Careful training for handling of BLS trigger cables
  - Remove ribbon cables from front, back and above-rack cable tray
  - Disconnect cables from old electronics
  - Apply Run IIb labels
  - Remove cable ties and secure cables in the vertical cable trays

- **After installation of Patch Panels**
  - Redress cables, connect to Patch Panel Cards, apply strain relief
- **Procedure documented in a D0 Note 4651.**
- **Note: It is possible that some fraction of BLS trigger cables will need to be reconnectorized after the installation of the transition system.**

Cabling: Pleated Foil Specifications

3M™ Pleated Foil Shielded Cable

.025″ 30 AWG Solid, TPE Primary, TPE Cover 90211 Series



- Can be used with IDC mass termination connectors
- Can be used in applications requiring standard impedance of 75 ohms single ended
- Extremely low crosstalk, used in the all signal mode to quadruple signal density as compared to standard .050 inch flat ribbon cable
- Perfect for board-to-board applications within electronic equipment, TPE cover prevents pleated copper foil from accidental shorting
- Solid pleated copper foil provides flexibility and 35 db average shielding effectiveness

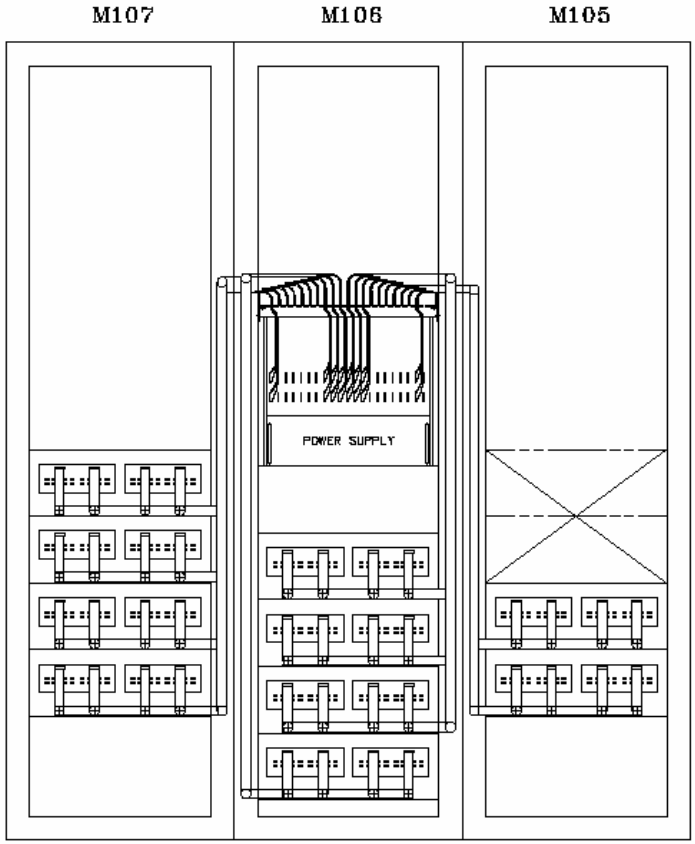
Date Modified: May 30, 2003

TS-0598-08
Sheet 1 of 2

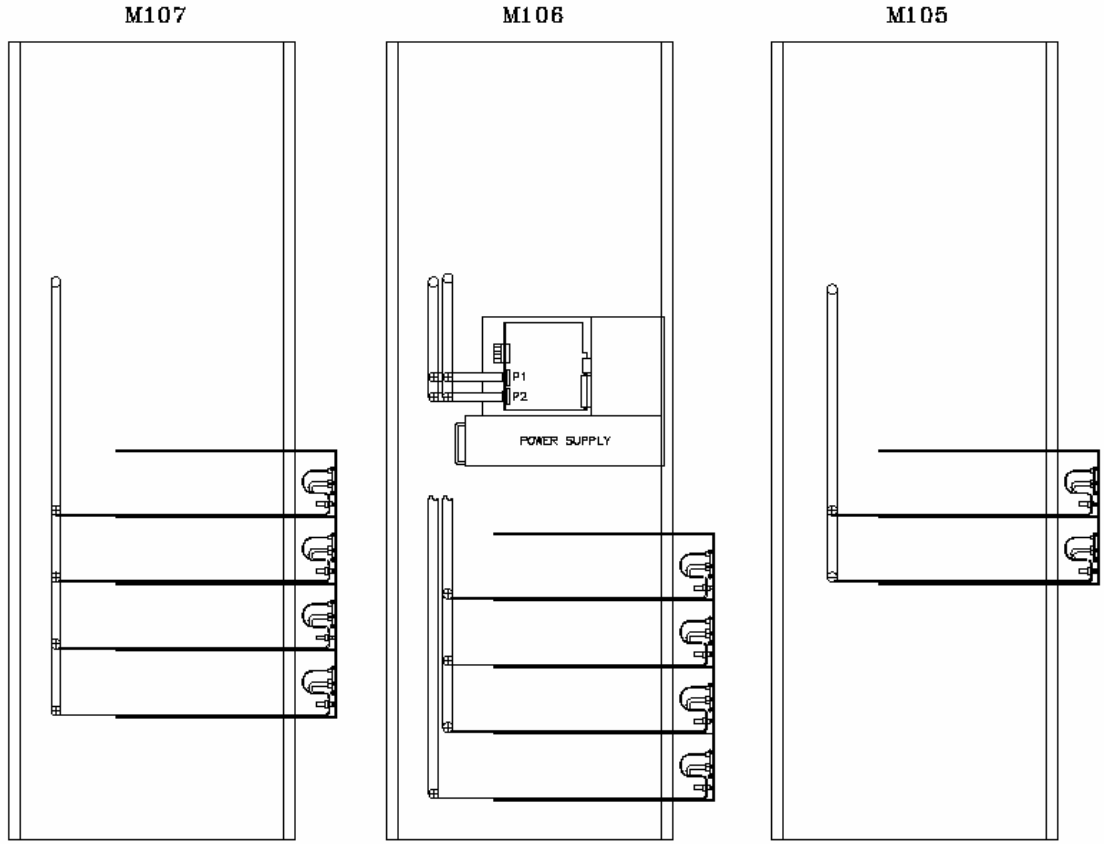
Good impedance match to BLS trigger cables (D0 Note 4692). Two pleated foil cables carry TT signals from each patch panel card to the ADF Cards via the ADF backplane. Need 160.

Cabling: Pleated Foil Routing

Rear View

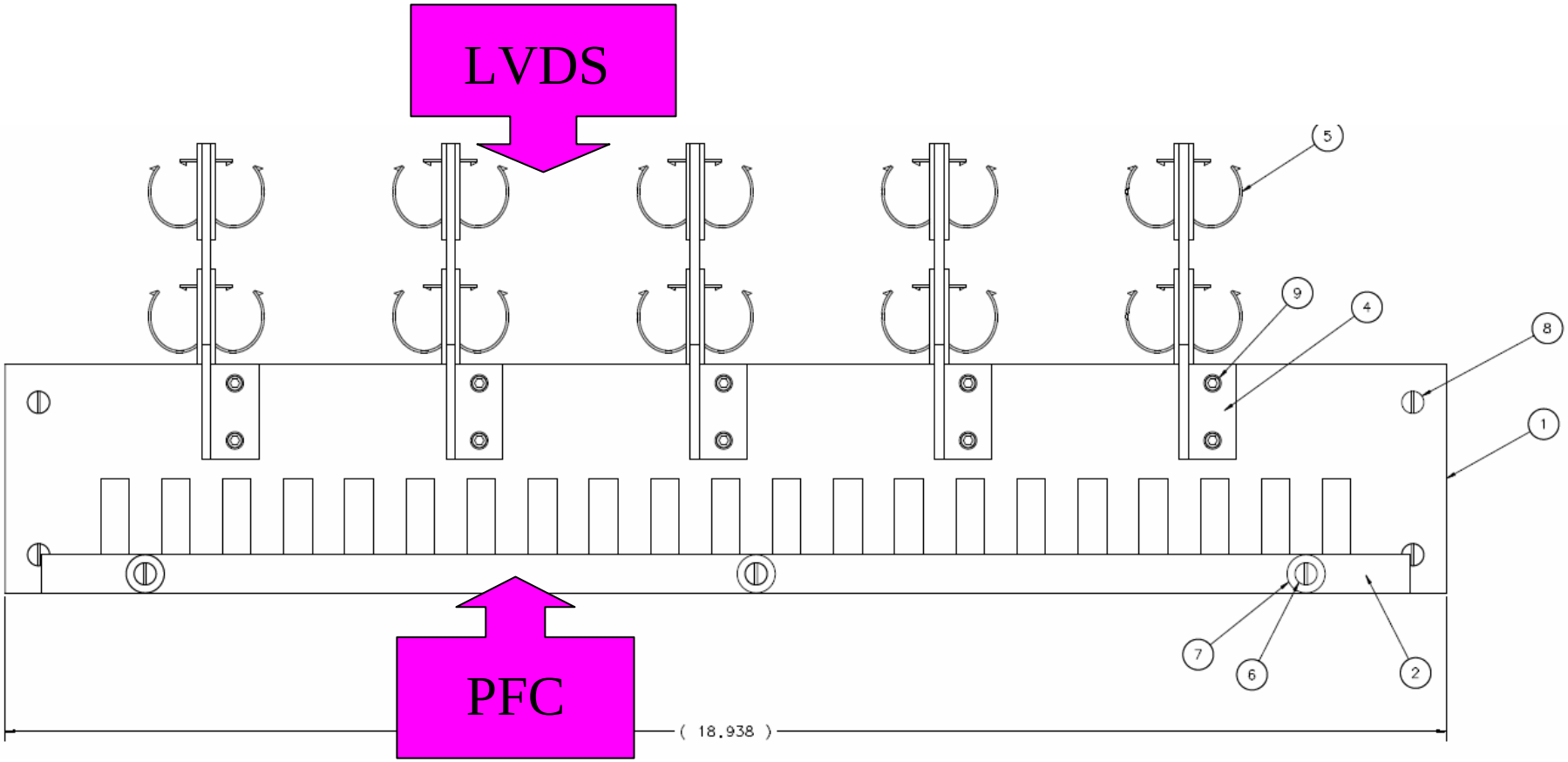


Side View



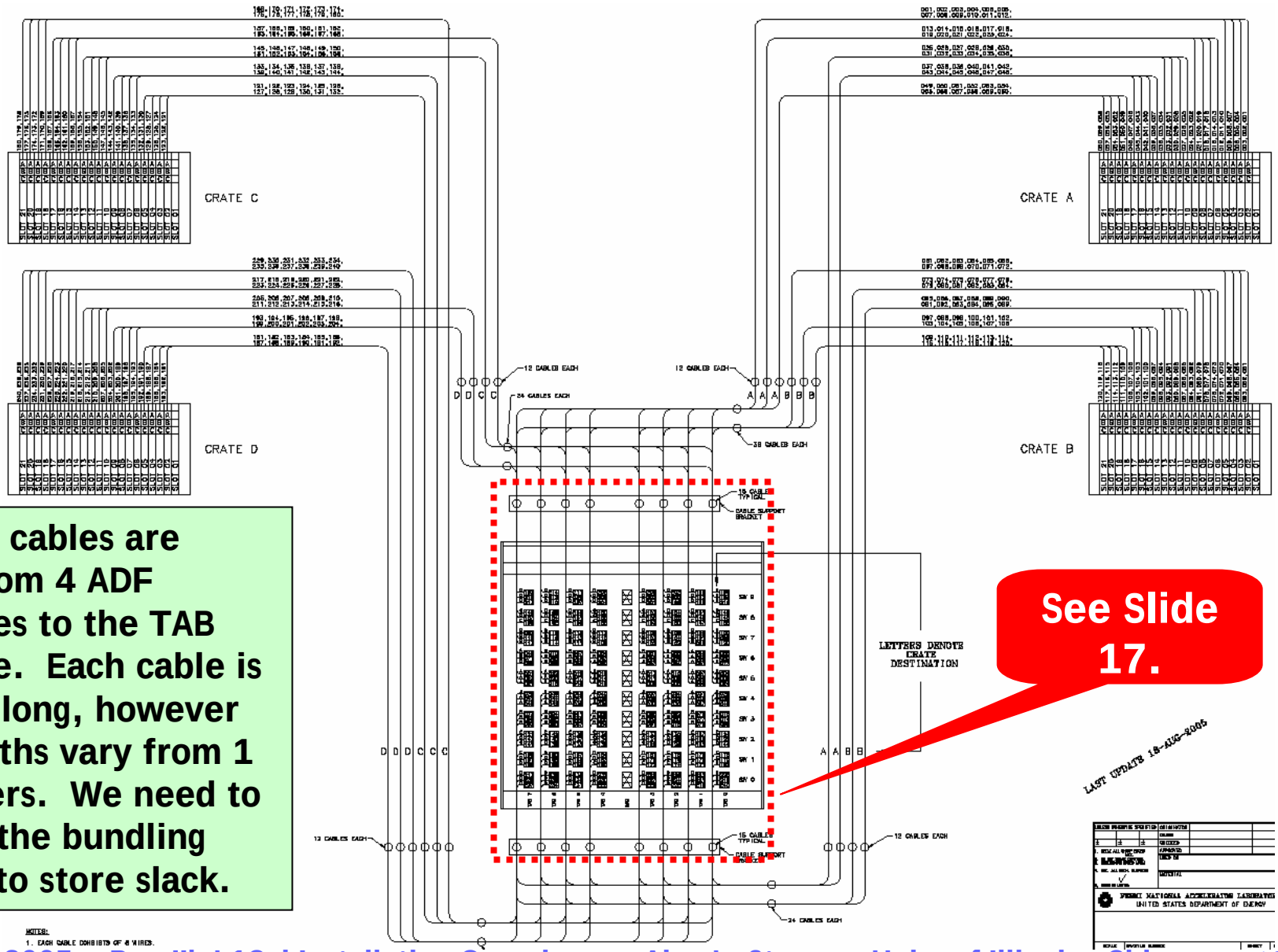
Pleated foil cables are 10 feet in length. The cables drape from the top of the ADF backplane so as NOT to block access to the power supply beneath the ADF crate.

Cabling: ADF Backplane Strain Relief



40 Pleated Foil cables fit in slots, and locked with crew mounted bar.
60 LVDS cables fit in plastic tabs with foam inserts. Back row is elevated.

Cabling: ADF-to-TAB LVDS Cables



240 LVDS cables are routed from 4 ADF backplanes to the TAB backplane. Each cable is 5 meters long, however path lengths vary from 1 to 4 meters. We need to describe the bundling and how to store slack.

See Slide 17.

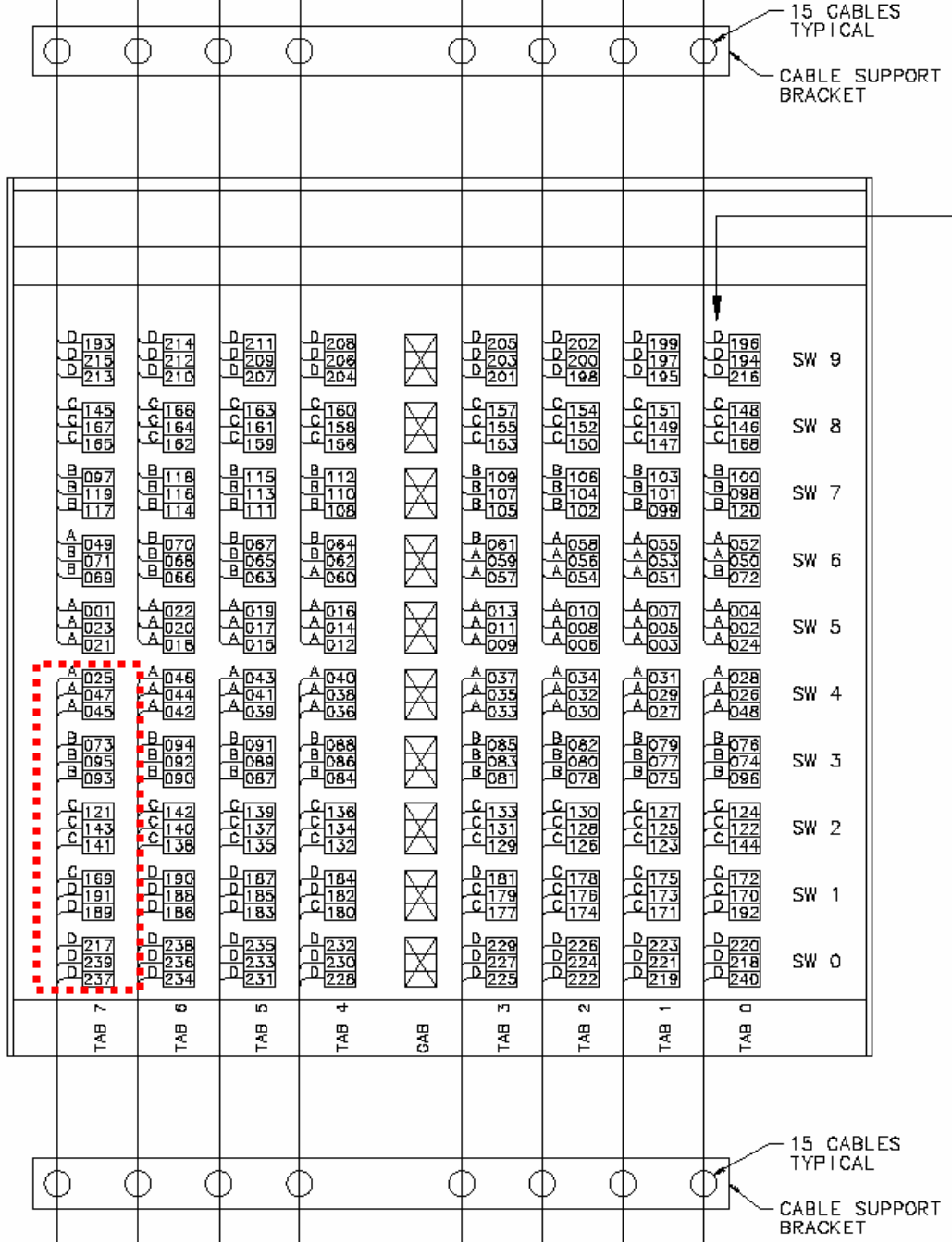
Cabling: TAB Backplane

The cabling of the TAB backplane is reminiscent of a telephone switchboard. Cables will have to cross to allow full access to the backplane, and to implement a strain relief system.

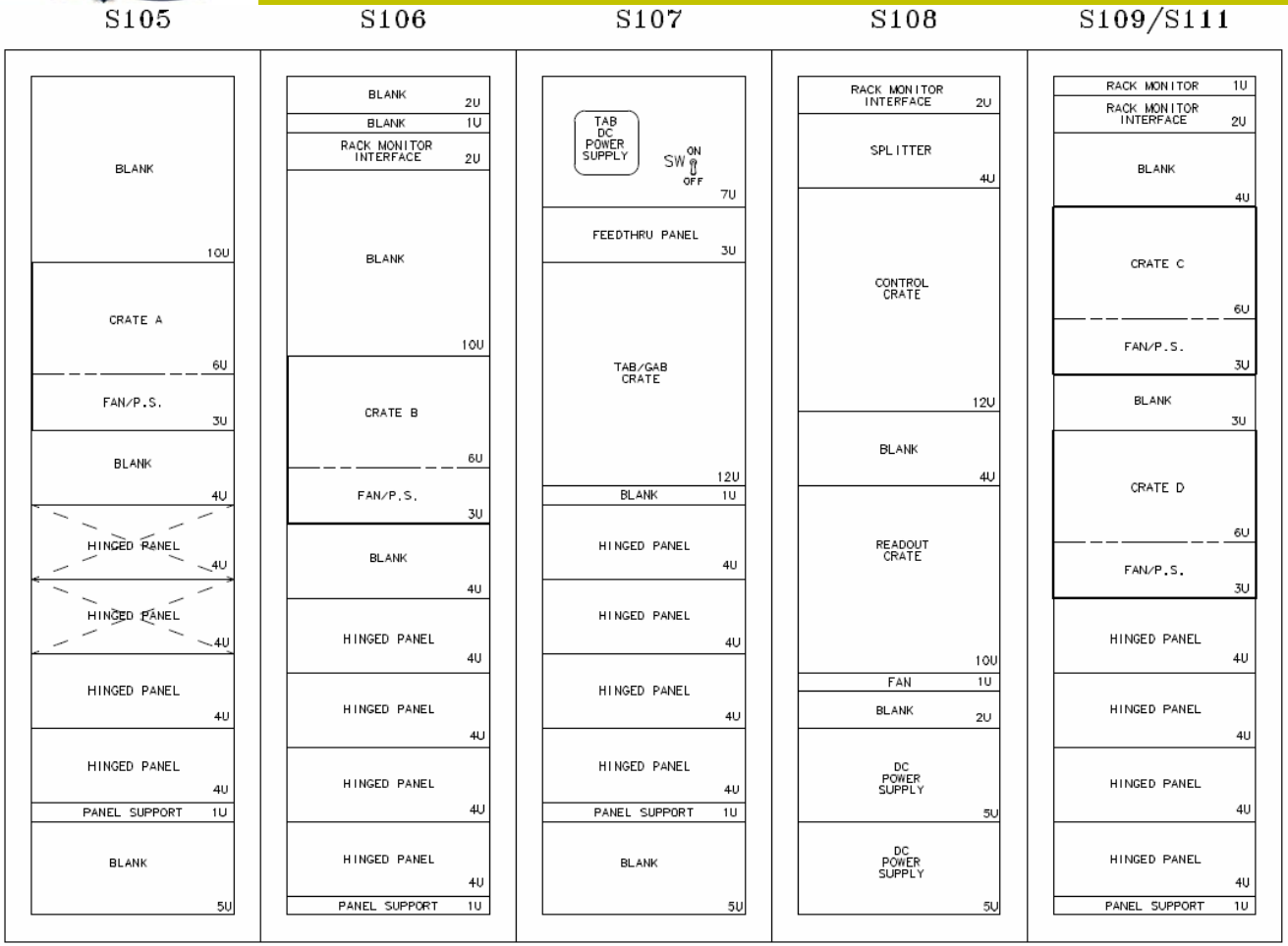
Connecting and routing begins from the TAB backplane to simplify bundling. 240 LVDS cables are initially sorted into 16 groups (see example in red dashed line).

Each TAB (column) receives TT signals for a slice of phi for all of eta. In this diagram, A-B-C-D refer to the four ADF crates. Each SW input to the TABs gets a copy from three adjacent ADF boards.

Pleated Foil and LVDS Routing is documented in D0 Note 4964.



Sidewalk Test Stand



We intend to keep the sidewalk test stand up and running through and after the shutdown for quasi long term needs.

The TAB prototype, VME control & readout crates stay on the sidewalk. We will use the spare ADF crate on the sidewalk.

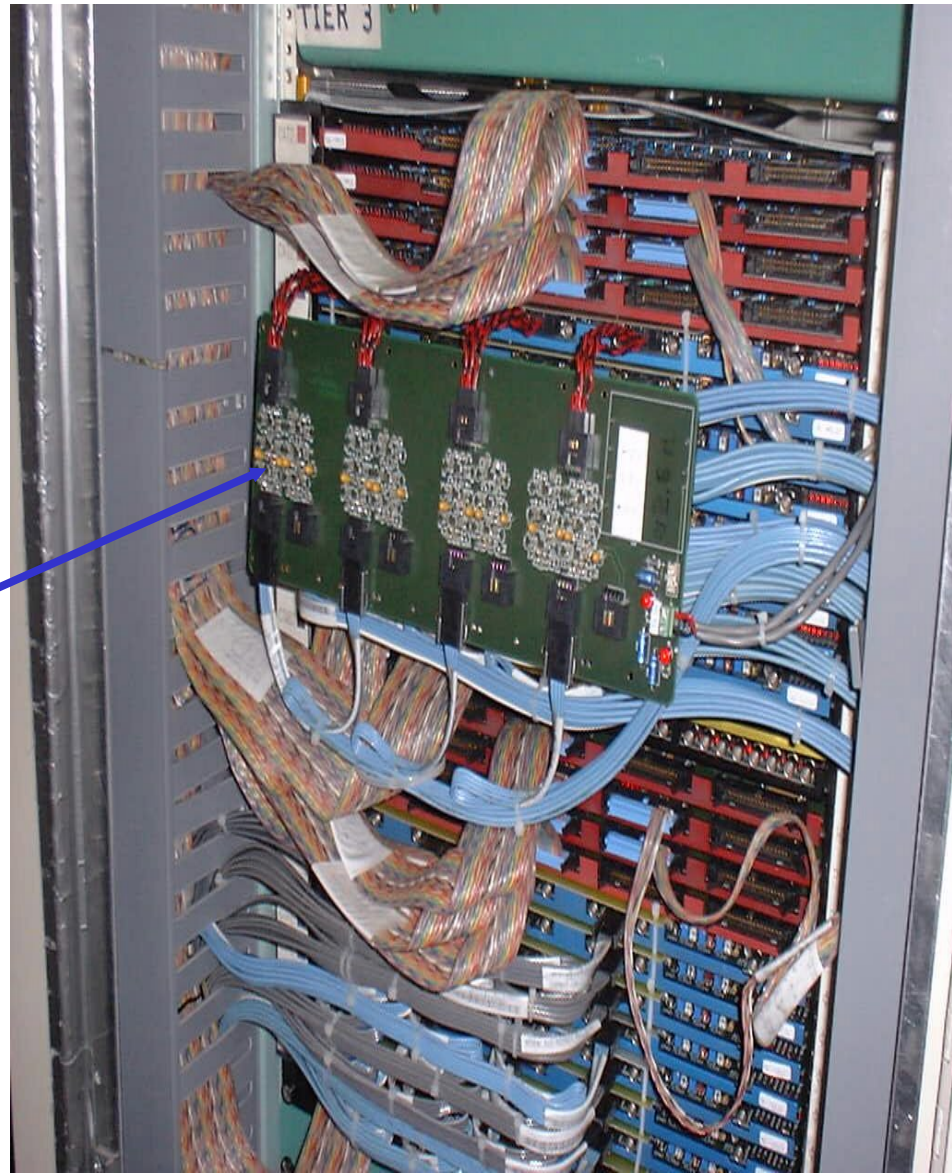
Power distribution is customized for sidewalk. Air cooling. RMIs with smoke detection.

Safety system allows 24/7 operation. pORC received 2 Sep 2005.

- Wooden platform adjacent to MCH1 near DAB pit isolated from building ground.
- Build the final Run IIb L1 CAL Trigger system with all active components.
  - Crates: 4 ADF, 1 TAB/GAB, 1 Readout, 1 Communication.
  - Online computer, L1 CAL Trigger control computer, BLS-to-ADF Transition System.

BLS Trigger Signal Splitter

- **Access to real TT data using Splitter Boards**
  - Designed and built by Saclay.
  - Active split of analog signals at CTFE input.
  - 4 TTs per board.
- **Splitter data**
  - No perturbation of Run IIa L1Cal signals.
  - Allows tests of digital filter algorithm with real data.
- **BUT**
  - At best, we will be able to install 4 splitters, for a total of 16 TTs (out of 1280).
  - Important to compare Run IIb TT with Run IIa TT and Precision Readout during a store & with the Calorimeter Preamp Pulser.



Pre-Installation Status

- Sidewalk Test Stand
  - Vertical slice of Run IIb signal path
  - Integrate into global readout
    - Monitor Run IIb data with current trigger & physics readout
  - 24/7 operation approved
- Cabling
  - Mock-up of BLS trigger cables
    - Very limited access before Run IIb installation in MCH1
  - Interrack wiring & strain relief drawings for Pleated Foil & LVDS cables done on sidewalk completed
    - Implement MCH1 procedures
  - Run IIb labelling scheme
- Transition System
  - 1 Patch Panel Card, 2 Pleated Foil Cables, 1 ADF Transition Card, 3 LVDS Cables are tested as a unit (80 in total, plus spares)
  - Only need full set of ATCs with LVDS cables for sidewalk operation
    - Finite set of BLS trigger inputs
  - 12 Patch Panels assemblies on sidewalk
    - Remaining assemblies are in DAB3, ready for shutdown
- Signal Electronics
  - Full set of ADF Crates & Boards tested & in hand at D0, with spare set-up at MSU
  - Full set of TABs & GABs at D0
- Communications & Readout
  - Crates & Boards in hand at D0
- Infrastructure
  - Reuse MCH1 racks
    - Strip them to frames during early weeks of shutdown
  - AC distribution boxes in hand
    - Plugs directly into current MCH1 power
  - Cooling systems
    - Commercial parts ordered
      - Heat exchangers, hoses, valves
    - Custom parts built at D0
      - Pipes, plenums
  - RMIs, smoke detectors in hand
  - Custom cable support systems
- Bulkhead panel for L1CalTrk
- Panels for BLS trigger cable monitoring

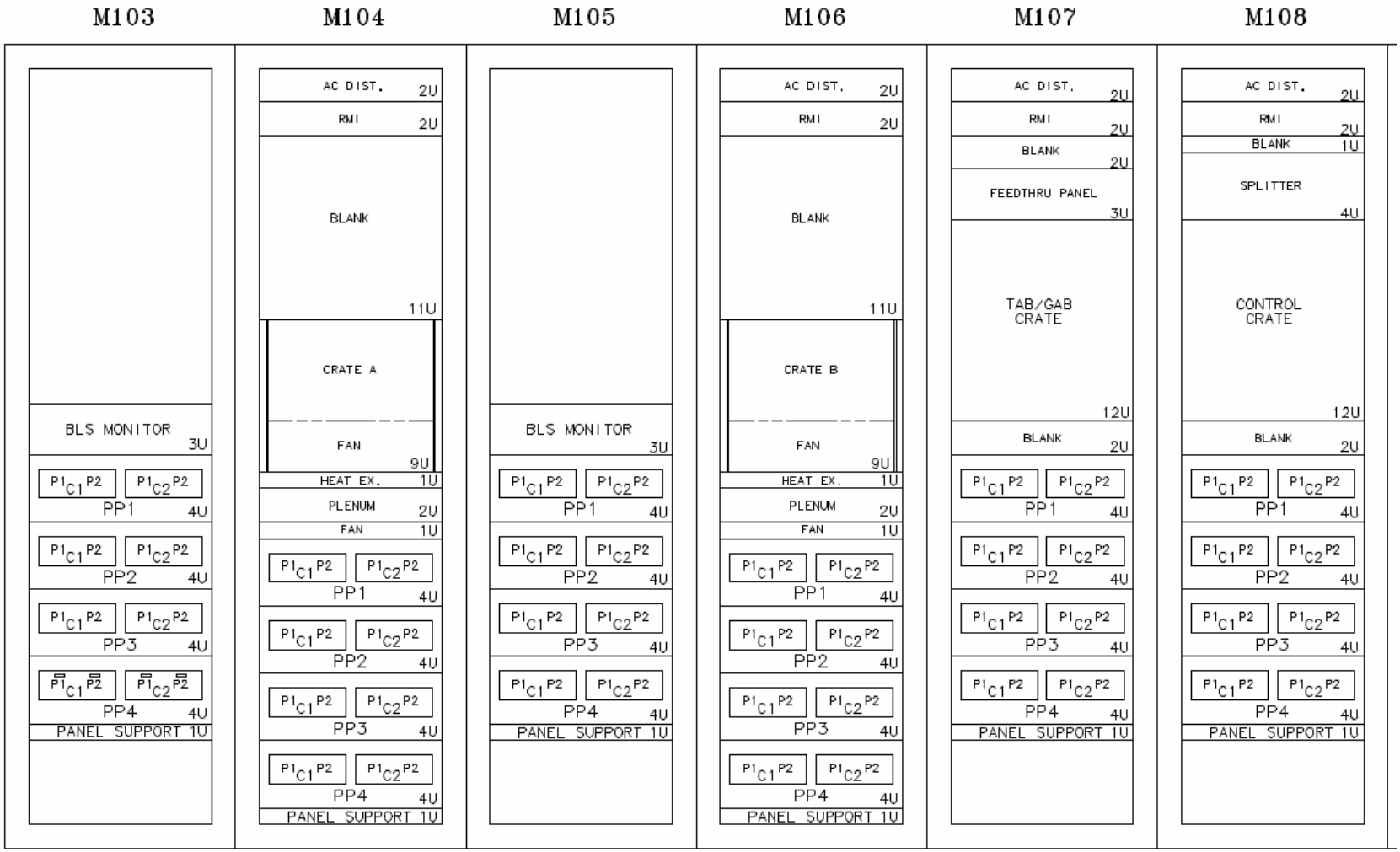
Status of Rack Infrastructure

Item name	Total	M103	M104	M105	M106	M107	M108	M109	M110	M111	M112
ADF Crate	6		1		1	1	1	1		1	
AC Distribution Box	6		1		1	1	1	1		1	
Rack Monitor	6		1		1	1	1	1		1	
Rack Monitor Interface	6		1		1	1	1	1		1	
1U Blank Panel	6		1		1	1	1	1		1	
5U Blank Panels 8-3/4"	6	1		1		1	1		1		1
Heat Exchanger	6		1		1	1	1	1		1	
Air Plenums	6		1		1	1	1	1		1	
Fan Pack	6		1		1	1	1	1		1	
Hinged Panels	40	4	4	4	4	4	4	4	4	4	4
Right Angle Chassis Supports	52	4	6	4	6	6	6	6	4	6	4
RA Alum. 1/8" thick - 19-3/4" X 2" X2" Chassis Suppo	24		4		4	4	4	4		4	
Unistrut Rails 78-3/4" long	40	4	4	4	4	4	4	4	4	4	4
21" X 18-3/4" X 1/6" thick Alum. Cable Shelf	40	4	4	4	4	4	4	4	4	4	
Water Manifold Supply	6		1		1	1	1	1		1	
Water Manifold Return	6		1		1	1	1	1		1	
Check Valve	6		1		1	1	1	1		1	
Solenoid Valve	6		1		1	1	1	1		1	
Flow Meter-Proteus	6		1		1	1	1	1		1	
Hoses	36		6		6	6	6	6		6	
Quick Disconnects - Male	36		6		6	6	6	6		6	
Quick Disconnects - Female	36		6		6	6	6	6		6	
Elbow	36		6		6	6	6	6		6	
Elbow	12		2		2	2	2	2		2	
Hardware - 1/4-20 Hex Bolts & Washers											

AC distribution boxes plug directly into existing MCH1 power. The Tygon hoses are in good condition. Will install new heat exchangers, water manifolds, hoses, valves and flowmeters, and tie into existing water lines. Saftey monitoring – smoke, air flow, water flow, water drip - for six racks with active components. Cable support systems being built in-house.

Run IIb L1CAL MCH1 Rack Layout

M103-105 = M110-112



Air & water cooling for ADF Crates. Air only for TAB/GAB & Communications Crates. Air, water and smoke interlocked with RMIs. 30 Amp Pulizzi for power distribution.

ORC: Sidewalk vs MCH1 Installation

Sidewalk

- AC Distribution
  - In-house design
- DC Distribution
  - ADF crate (<700W): Wiener crate/PS combo
  - TAB/GAB crate (<300W): Bench top supplies
  - Controls crate (<200W): Run IIa crate/PS combo
  - Readout crate (<330W): Houses VME/SCL card
- Fire Protection
  - Standard RMI: Smoke, Air Flow

MCH1

- AC Distribution
  - Commercial
- DC Distribution
  - ADF crate: Same
  - TAB/GAB crate: Wiener PS, fuse panel
  - Controls crate: Wiener crate/PS combo
  - Readout crate: No VME/SCL card
- Fire Protection
  - Standard RMI: Smoke, Air Flow, Water

http://d0server1.fnal.gov/users/bagby/www/L1defaultorc.htm	
System	L1_Calorimeter ORC Documentation .pdf , . doc Rack Layout.pdf AC Distribution .pdf
ADF Crate	ORC Documentation .txt
TAB/GAB Crate	DC Distribution .pdf TAB_GAB Backplane Diagram .pdf
Control Crate	ORC Documentation .txt Wiener Specifications .pdf
Readout Crate	VME/SCL DC Distribution .pdf VIPA DC Distribution .pdf VIPA Backplane Mechanical Drawing .pdf VIPA Backplane Schematic .pdf VIPA Backplane Sense Fuse/Thermistor Specifications .pdf

Component Status

Item	Need	In Hand	Comments
Patch Panels	40	44	12 assembled on sidewalk. The rest are in DAB3.
Patch Panel Cards	80	93	Extended BLS-to-ADF Transition System 1 Patch Panel Card + 2 Pleated Foil Cables + 1 ADF Transition Card + 3 LVDS Cables are tested as one unit (80 in total, plus spares).
Pleated Foil Cables	160	185	
ADF Transition Cards	80	89	
LVDS Cables	240	256	
ADF Boards	80	100	Fully tested. At D0.
ADF Crates, PS + Fan Tray	4	5	Plus spare power supply, fan tray. Back-up crate at MSU.
TAB/GAB Crate	1	2	Prototype on sidewalk is back-up (with modified power supply)
Trigger Algorithm Board	8	12	All available. Several TABs with 1 GAB in use at D0.
Global Algorithm Board	1	3	
Communication Crate	1	1	At D0 in use on Sidewalk.
SCLD Board	1	2	1 at D0, 1 at MSU. In use.
VME/SCL Board	1	3	1 Final (in use) + 1 Prototype at D0. 1 Final at Nevis.
Readout Crate	1	1	Reuse MCH1 crate for Run IIb. Spare readout stays on sidewalk.
Other Cables	68	All + spares	L2/L3 (27), SCLD (4), TAB-GAB (8), GAB-TFW (4), L1CalTrk (24)

Testing of BLS-to-ADF Transition system components (including spares) was completed by Jorge Benitez on Nov 23rd. Additional LVDS spares at Nevis (or in transit to D0).

Photos from the Sidewalk

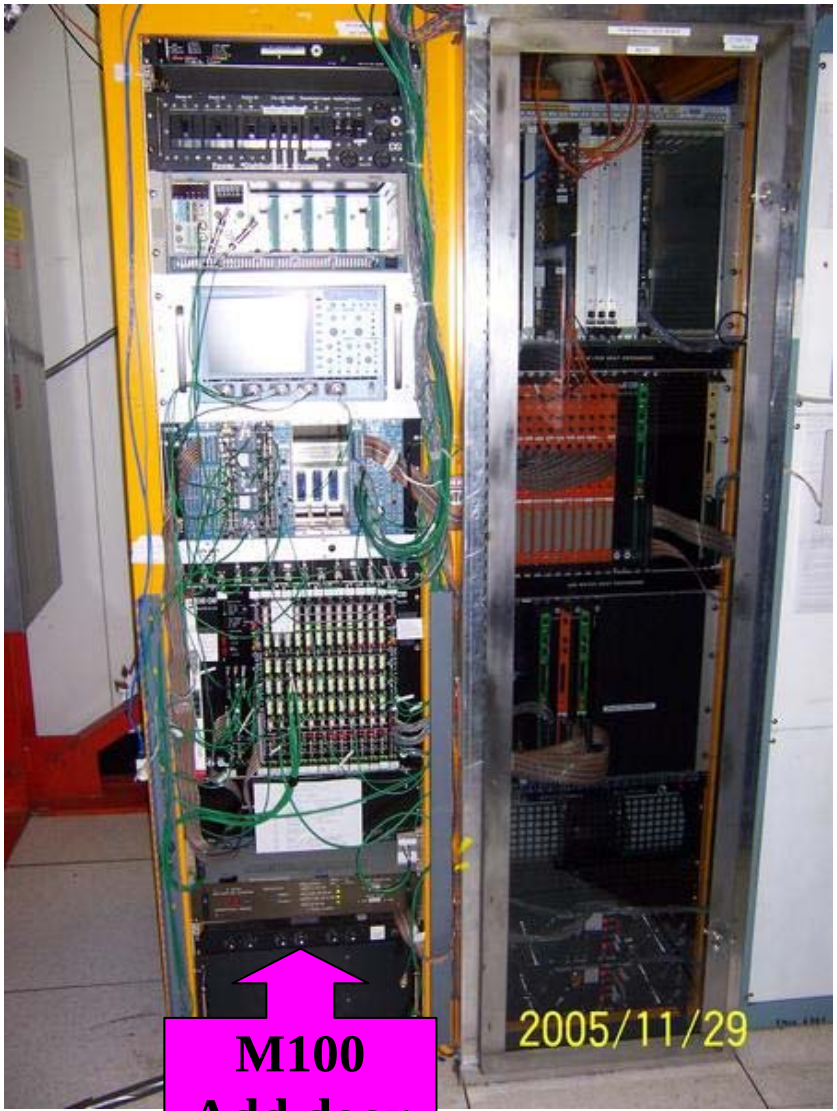
Status of Sidewalk Installation

- All components ready except TAB/GAB production crate
  - Weiner power supply was shipped to Springfield, OH for repairs on Mon (Dec 5th), arrived Tue (Dec 6th) and fixing has begun.
    - 6 V supply drifting (right out of the box), and a couple of transistors were smoking on bench load test.
    - Under warranty. Will do 5 hour test after repairs. Will FedEx back to us on Wed (Dec 7th), and have on-hand at D0 on Thu (Dec 8th) or Fri (Dec 9th) at the latest.
- Rest of installation follows serially (from Mon Dec 12th)
  1. Revised pORC docs ready. Request Dan Wolf for inspection.
  2. Install 80 ATCs.
  3. Begin ADF-to-TAB LVDS cabling (240 cables).
     - Expect 2-3 days. Need 1-3 volunteers, preferably people who will do this task in April **(see Slide 27).**
  4. Route 4 SCLD LVDS cables.
  5. Install 80 ADFs, 8 TABs, 1 GAB.
  6. Route 8 TAB-to-GAB LVDS cables.
  7. Begin full-scale ADF-to-TAB integration tests.

Shutdown Installation Overview

Item	Start Date	Duration	Persons	Comments
Shutdown	1 Mar 2006	14 wks		L0 (L1CAL) dominates installation (commissioning) schedule.
Noise Studies	2 Mar 2006	1 wk		Need Run IIa L1 CAL trigger. Decouple beam pipe. Etc.
Decable BLS Trigger Cables	13 Mar 2006	1 wk	2 Phys	Add doors to M100 & M102. Isolate/protect ECL cable in M105. Dismount M103-112 doors. Remove/cut/discard ribbon cables. Disconnect 1280 BLS cables, relabel, store in vertical cable guides.
Remove Run IIa Electronics	20 Mar 2006	2 wk	2 Tech	Strip M102-113 racks to frames. Leave AC conduits above racks.
Install Run IIb Services	3 Apr 2006	3 wk	2 Tech	Install and test power, water, air, safety services. Install 40 patch panels assemblies.
Reconnect BLS Trigger Cables	17 Apr 2006	1 wk	2 Phys	Redress. Strain relief.
Install Crates, TCC. Power.	24 Apr 2006	1 wk	2 Tech	4 ADF, 1 TAB, 1 L1CAL TCC. Reuse current Readout, Comm.
Pleated Foil, LVDS Cables	28 Apr 2006	1 wk	2 Phys	Route. Strain relief.
Other cabling	1 May 2006	1 wk	2 Phys	L2/L3 Optical. GAB-to-TFW. L1CalTrk Match. SCL.
System Checkout. ORC.	8 May 2006	1 wk	2 Tech, 2 Phys	Install rack doors. ORC approval. Cabling, mapping.
Commissioning	>15 May 2006	6+ wks	Multi-Physicists	

MCH1 Rack Photos



Installation Comments

- Some work can overlap.
  - Staggered work over the full set of racks.
  - Items with common color code on Slide 10.
- Schedules for various cabling is based on experience from performing mock-ups.
  - Procedures documented, and pre-installation training is assumed.
- All durations assume one shift per day of either physicists or engineers.
  - May have two crews for some tasks working in parallel
    - Constraints: Space, power interruptions, noise
  - May have multiple shifts per day to accelerate well-defined tasks
    - Constraints: Limited expertise
- L1 CAL upgrade has priority for MCH activities during installation.
- Duration for stripping racks and installing services provided by John Anderson.
  - L1 CAL trigger upgrade will have to draw from the same pool of resources for mechanical and electrical support.
  - No engineer or technician is working 100% on L1 CAL.
  - We are assuming that overtime will not be an option.
  - A lot of advanced work is already done in building, ordering, and preparing all rack infrastructure.
- Need to assign names to each task.
  - We already have a good idea of how much person power is needed.
  - May need to "draft" all available local manpower for cabling efforts.
    - Takes place during March & April
  - Finite list of post-docs & grad students.
  - Will need some specialized training and review of procedures.

Installation Person Power

- Decable & Label BLS Cables
  - Two persons work as a team
  - 2 racks per day
  - Two teams can work in MCH1 at a time (physicists)
- Remove Run IIa
  - Remove ribbon cables, boards, power supplies, heat exchangers
    - Removal is faster as the components do not need to be recovered
    - Leave air ducts above racks to save time
  - Two persons work as a team
    - Technicians, but will need engineering supervision
  - 1 rack per day
  - Two teams may work at opposite ends of MCH1 at a time
    - But, may only have support for one team per day
    - May require welder to cut apart sub-crates
- Install Rack Infrastructure
  - Technicians, following engineering designs and rack specifications
    - Estimate 1 rack per 2-3 days
    - 6 racks with services
    - Test services (checklist)
  - Patch panels can be installed by physicists (<1 week)
- Reconnect BLS Cables
  - Services are done from rear of rack, BLS cables from front, possibility for overlap
  - Same plan as “Decabling”
- Crate Installation
  - Transport from Sidewalk to MCH1
  - Connect to power
  - Strong backs
  - Could take only a day
- Other Cabling
  - Pleated Foil & LVDS Cabling plans similar to BLS Cabling
  - Rest of system uses <100 cables which can be routed & connected < 1 day
    - TFW, TAB-to-GAB, L2/L3, L1CalTrk

Summary

- Electronics in hand & tested
  - All Crates & Boards
- Transition System in hand & tested
  - Includes >10% spares
- Infrastructure ready
  - All Power & Safety Services
  - Cabling: Routing & Support Structures, Labels
- Safety
  - Sidewalk: pORC received Sep 2
  - MCH1: need approval about 8 weeks into shutdown
    - Docs nearly ready, submit in advance for consideration
- Documentation
  - Labelling complete
    - Tested mechanically & with software
  - Cable installation pending
    - BLS decabling & recabling
    - PFC, LVDS routing & strain relief
- Installation Features
  - Technician & engineering support
    - Could accelerate decommissioning of current racks & installation of Run IIb services with overtime and/or extra person power (front-loaded)
  - MCH1 decommissioning uncertainty
    - Not feasible to do a full mock-up
    - Original racks were built at MSU & rolled-in as complete in early Run I
  - Detailed plan for BLS trigger cabling
    - Careful training for anyone handling these cables
  - List of dead & noisy channels
- Final Installation Schedule
  - Assign individual names to all tasks
    - Factor in university schedules
  - Need daily breakdowns with Plan A & B
    - And multiple shifts, weekends
  - Integrate with other systems
    - Run Coordinator, Calorimeter, DAQ, Mechanical & Electrical Ops